CEMENT
AND
CEMENT MANUFACTURE
INCORPORATING "PORTLAND CEMENT"

VOL. 2. NO. 4. APRIL, 1929.

White Portland Cement.

THE announcement that a British-made white Portland cement is on the market puts an end to the long period during which this country, justly to be regarded as the home of the Portland cement industry and one of the chief cement exporting countries of the world, has been dependent upon foreign white cement for its requirements. There are two reasons which probably account for the delay in arriving at a self-supporting position in this matter; first, the lack of any great commercial inducement owing to the small demand for white cement; second, technical difficulties of manufacture. The consumption of white Portland cement in Great Britain has admittedly been small hitherto and not sufficient to maintain continuous output from the smallest of cement manufacturing units, but the development of the cast stone industry has increased the consumption of white cement and promises to multiply the demand in the near future. The possibilities of decoration with a white plaster have been known for ages, and have been used to the full extent in internal work with the aid of plasters having a gypsum base, but only of late has similar external decoration been employed with white Portland cement either in the form of plaster or cast stone. There is certain to be a growing demand for a white external decoration of this nature combining all the beauty of the gypsum plaster medium with the durability of Portland cement which the gypsum material cannot claim. There is also no reason why Great Britain should not take its proper place as an exporter of white Portland cement, and the first manufacturers of this commodity, new to British industry, should have a reasonable prospect of reward for their enterprise.

The technical difficulties of the manufacture of white Portland cement are greater than appear on the surface. It is often glibly stated that white cement is made by adopting the usual cement manufacturing process and using raw materials as free as possible from iron; there are probably many cement chemists who have made a few ounces of moderately white cement in the laboratory in this way. But it is when the ounces have to be enlarged to tons that the real

difficulties emerge, and the commercial production of white Portland cement does not follow the simple orthodox lines that might be imagined.

The selection of raw materials reasonably free from iron is in itself no easy task, and the all-pervasiveness of iron in nature is not fully realised by the chemist until he comes to deal with the fractional percentages that alone can be considered in connection with white cement. Scrupulous care is also needed in the manufacturing processes to prevent adventitious contamination with iron and other colouring materials. Then again the bewildering number of tints possible in a so-called white material are not appreciated until comparisons are made. There are creamy whites, ivory whites, silvery whites, and dead whites, each of which by itself may claim to be regarded as white, but the white cement manufacturer cannot remain content with any hyphenated variety; none but the purest white which is capable of being tinted to any desired shade is permissible in this connection. It is perhaps not generally known that none but white cement can be used in the production of many of the coloured cements on the market.

The marketing of a British-made white Portland cement at a considerably lower price than the imported article has great possibilities before it. The limited applications of coloured concrete that have already been seen in a few examples of bridge building and other large-scale work in this country have given an indication of the artistic developments that are possible, and when the range of colouring rendered possible by the use of a comparatively cheap white cement becomes known there should be the beginning of a new era in artistic construction.

"False Set" of Portland Cement.

WE have received the following from Mr. H. R. Brandenburg, Chief Chemist of the Cowell Portland Cement Co., of Cowell, California :—

" In your January number I note an article ' The False Set of Cement,' and wish to make a few comments on the subject which may interest your readers. False-setting cement, also known as ' gum ' setting cement, came to our attention a few years ago in testing a product made by another company. After investigating this phenomenon, and being unable to blame the cement proper for this condition, since not only its composition but combination, as microscopically examined, appeared to be perfect, we came to the conclusion that something else had happened.

" Eventually I proved experimentally on our own and other brands of cement that a ' gum ' set can be induced artificially in any well made cement by raising the finish end mill heats to a sufficiently high temperature, i.e., 230 deg. F., and above.

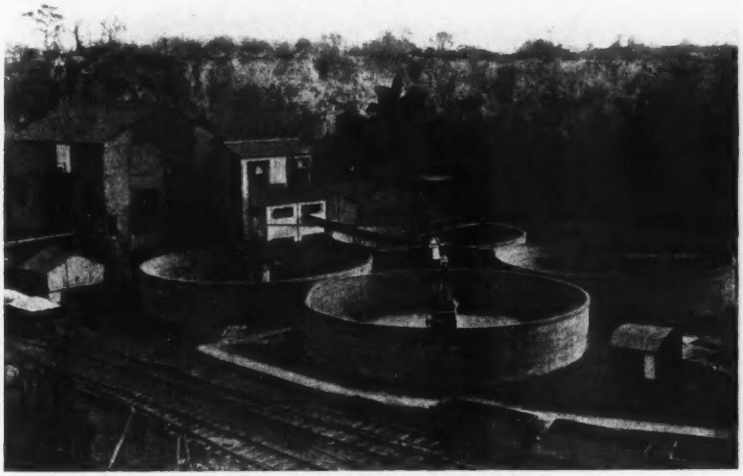
" Evidently the entirety of the gypsum becomes converted to anhydrite, thus losing its solubility and speed of reaction efficiency as a retarder."

Johnson's Cement Works, Greenhithe.

ENLARGED TO 400,000 TONS A YEAR.

The Johnson's Works of The British Portland Cement Manufacturers, Ltd., situated on the southern bank of the Thames at Greenhithe in Kent, are now approaching the completion of an extensive reconstruction and enlargement. The reconstructed works will have an annual output of about 400,000 tons of cement.

The chalk quarry adjoins the works. Clay is obtained from two sources, one



Wet-mill and Slurry Mixers.

a London clay deposit two and a half miles distant, where the clay will be washed and pumped to the works; and the other from land near the works.

Chalk Quarry.

The output of chalk required is 120 tons per hour throughout a working week of 140 hours. This material will be handled by an electrically-driven navvy. This machine, which weighs 92 tons, travels on a caterpillar track and has a bucket capacity of 3½ cubic yards. It is connected by means of a trailing cable to a substation of the outdoor type, at which the electricity is transformed from 3,000 to 500 volts.

The quarry face, which is about 100 ft. to water level, is at present being worked in 30/35-ft. stages. The overburden is stripped by means of an oil-driven navvy. The top stage is operated by a steam navvy, and the development on the second stage by a similar machine. The chalk is dumped into

10-ton railway trucks, and hauled in rakes of twelve trucks to the washmill by steam locomotives.

Washmill.

The loaded trucks after arrival from the quarry gravitate down an inclined siding into a side discharge wagon tippler. The chalk is tipped into a hopper, from which, by means of a two-way valve plate, it is fed into either of two wash-mills. These two mills are of standard design, being 30 ft. in diameter. Each mill is driven by a 225-h.p. motor geared through a single-reduction totally-enclosed gear to the countershaft. For cleaning out purposes the mill is driven by the same motor through a liquid starting resistance, by means of which the mill can be " inched " round as required. Each motor and control gear is housed so that the operator has a clear view of the interior of the mill at all times.

The slurry gravitates from each washmill to three central discharge elevators, delivering through a feed-trough to eight vibrating screens. The screened slurry passes through into a distributing trough fitted with weir-type control outlets which feed it into four 6 ft. diameter by 30 ft. long peripheral discharge wet tubemills. Each tubemill is driven by a 350-h.p. motor through a set of double reduction gears. These gears are totally enclosed and run in oil. The final drive is by a cardan shaft fitted at each end with flexible couplings connecting to the trunnion end of the mill. Each mill motor, as with all motors of 100-h.p. and over, is fed by 3,000-volt A.C. current, the control gear comprising iron-clad draw-out type trucks.

The rejects from the vibrating screens are conveyed by a reversible belt-conveyor into either of two 20 ft. diameter grit mills on the first floor of the washmill, the fine slurry from these mills gravitating back to the washmills and the flint grit concentrates discharging direct into 10-ton trucks below. Each grit mill is driven by a 30-h.p. motor through an enclosed-worm reduction gear to the countershaft. All elevators and conveyor drives in the mill are driven through similar D.B.S. worm gears direct-coupled to the motors.

The flints from the washmills discharge into a flint excavator situated between the two mills, and discharge through a hopper on the grit-mill floor into the grit trucks below. The flint wash-water is handled by a two-throw drainage pump situated on the washmill discharge level. The fine slurry leaving the tubemills flows to three slurry elevators of the same type and capacity as the coarse slurry elevators, and the discharge flows through a launder to a distributing box situated centrally between four slurry mixers. These air-agitated reinforced concrete slurry mixers are 66 ft. in diameter by 11 ft. 4 in. high, the capacity of each mixed being about 600 clinker tons.

All four mixers are interconnected by valves and pipes for equalising purposes, and a second set of suction and delivery pipes connected to one of the pumps in the pump house serves for conditioning purposes.

Clay Supply.

At the London clay deposit the clay is dug by a steam shovel, deposited into trucks, and hauled by steam locos to a washing plant. The clay slurry is

pumped by electrically-driven pumps through a 6-in. diameter main feeding into 66 ft. diameter slurry mixers with " sun-and-planet " stirring gear.

The clay deposit on the land adjoining the works is being excavated by means of a floating dredger. An electrically-driven grab at the forward end deposits the clay into a clay hopper which feeds into a washmill at the rear end of the dredger, and the clay slurry from the screens flows into a sump in the centre. From this sump it is pumped by a centrifugal pump through a 7-in. diameter floating delivery main to a 20-ft. diameter storage tank on the shore. From this tank the slurry gravitates to one of two slurry pumps in an adjoining pump house. The power for these two electrically-driven pumps and also for the floating dredger is brought by underground cables to an outdoor-type transformer, in which it is stepped down from 3,000 volts to 500 volts, the supply to the dredger being carried by means of floating cables.

The clay slurry is pumped through a 6-in. diameter pipe-line back to a 66-ft. diameter " sun-and-planet " mixer, two mixers acting as storage supplies for the two clay slurries.

Adjoining these two storage supplies is a 48-ft. diameter air-agitated clay mixing tank, into which clay slurry from the two storage tanks is led and mixed to form a constantly regulated mixture. These two slurries gravitate from each of their respective storage tanks through regulating valves into an existing sump equipped with a bucket-wheel elevator, the mixed slurry flowing from the elevator delivery through a trough into the 48-ft. air mixer.

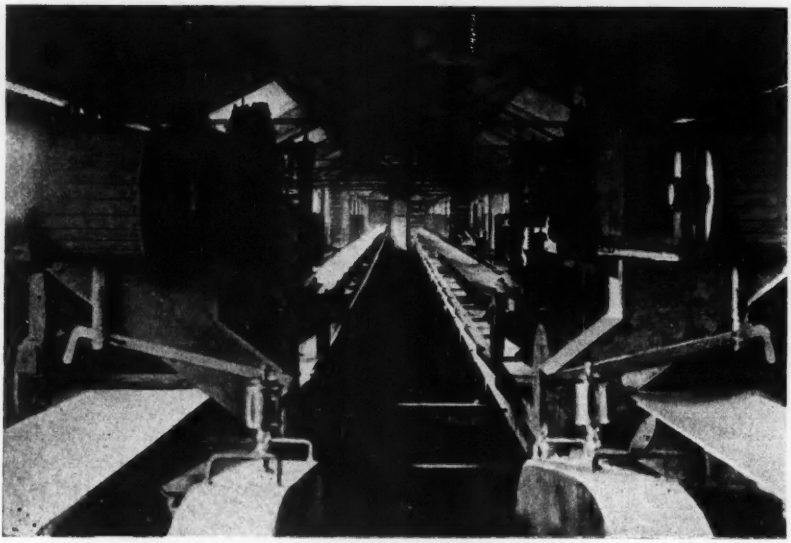
The mixed clay slurry then flows into a small pump house, in which are situated four electrically-driven slurry pumps which pump into delivery mains delivering clay slurry to a measuring tank at the washmill. This tank, situated above the grit-mill floor, holds an adjustable supply of clay slurry. Part of this clay supply leads direct to the grit mills and the remainder to the washmills, the operation of the tank being controlled by the man who works the chalk tippler.

Pump House.

The slurry from the four 66 ft. air-agitated storage mixers is led by control valves and a 15-in. diameter suction pipe into the main pump house nearby. This building, which was formerly one of the cement warehouses and is 120 ft. long by 92 ft. wide, is divided into three equal bays. The northern bay, which contains band and circular saws, slotting machine, and other tools, is the wagon repair shop. The central bay is the main pump house, and is equipped with six sets of slurry pumps. All the slurry pumps—thirteen in number—in use on the plant are of the one design, three-throw plungers, 12-in. diameter and 15-in. stroke. Each of these six pumps is connected by stop valves to the one 15-in. diameter suction main, and each delivers, again by means of suitable stop valves, to delivery mains, 8-in. diameter, carried on an overhead gantry leading the slurry to the four kilns.

These six pumps, which extend down the centre line of the building and over which runs a 7½-ton travelling crane, are driven through an overhead

New Rotary Kilns.



Clinker Conveyors and Motor Driven Trippers.

countershaft at the side of the bay by independent belts, the countershaft being driven by a 150-h.p. motor in the centre of the southern bay. This bay is divided into three sections; one is a storeroom; the centre section is the motor house; the end section contains another motor-driven slurry pump connected by a common suction and delivery main to the four 66-ft. slurry mixers, and is used for transferring slurry from any one mixer to any other for conditioning purposes.

Rotary Kilns.

The completed plant will consist of four rotary kilns; two existing kilns, called respectively No. 4 and No. 5, each 202 ft. long, 9 ft. diameter, with an enlarged burning zone 10-ft. diameter, will give a combined output of 2,700 tons of clinker per week. Each kiln is provided with a rotary cooler set at right angles to the axis of the kiln. The kilns are driven through the ordinary gearing and belt drive by totally-enclosed A.C. commutator motors (65/22 h.p.), having a speed variation ratio 700/230 r.p.m., 3-phase, 500 volts, 50 cycles. The two new kilns, No. 6 and No. 7, are each 317 ft. long overall with a burning zone 46 ft. and 12 ft. diameter.

The clinker coolers are of the recuperator type; twelve cylinders, each 4 ft. diameter and 20 ft. long, are placed round the discharge end of the kiln, the centre line of the cylinders lying parallel to the centre line of the kiln. The hot clinker leaves the kiln shell at the extreme end, discharging into twelve holes on its periphery and thus entering into each of the twelve cooler cylinders. In each of these, through the medium of spiral guides, the clinker is slowly transferred to the discharge end where it falls on to a shaker conveyor. These kilns are supported on six roller bedplates and are driven through four sets of reduction gears. The first and second reduction gears are totally-enclosed and run in oil under a system of forced lubrication to the bearings and sprayed on the teeth. The motors for these drives are of the variable-speed commutator type of 150/47 h.p., 650/225 r.p.m., 500 volts, 3-phase, 50 cycles, totally enclosed and water-cooled. The revolutions of the kiln can be varied from a maximum of 1 in 70 seconds to a minimum of 1 in 210 seconds.

Slurry Feed.

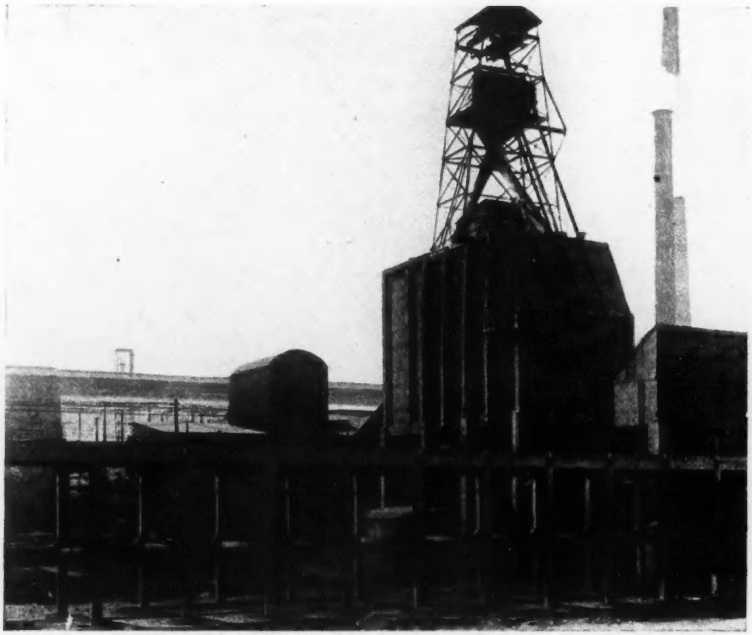
The slurry leaving the pump-house is conveyed through an 8-in. diameter main to the feed end of the kilns, leading in succession to the spoon feeds above kilns Nos. 7, 6, 5 and 4, the delivery to each spoon feed being controlled by a valve on a tee-piece connecting to the slurry main. The existing spoon feeds on kilns Nos. 4 and 5 are belt-driven by a belt passing round the shell of the kiln. The feeds on kilns Nos. 6 and 7 are electrically driven by variable-speed D.C. motors geared to the drive-shaft of the spoon feed. The variation in feed is controlled and governed by an adjustable variable-shunt resistance on the kiln firing-floor.

The overflow from the four spoon-feeds is taken by a separate pipe-line to an existing 66-ft. diameter mixing storage tank situated behind kilns Nos. 4 and 5. The accumulated slurry in this mixer flows by a suction pipe to three

3-throw slurry pumps near the feed end of No. 6 kiln, and is thence pumped back to the 8-in. slurry main to feed the four kilns.

Coal Supply.

The coal arrives at the works siding in standard 10-ton colliery wagons. The loaded wagons are placed in rakes of seven at a time on to an incline, from which they gravitate one at a time over a side discharge tippler (a duplicate of that at the washmills) and discharge into a double-compartment bin, each compartment discharging on to a rotating feed-table which delivers the coal into skips holding $1\frac{3}{4}$ tons each. These two skips alternately lift to



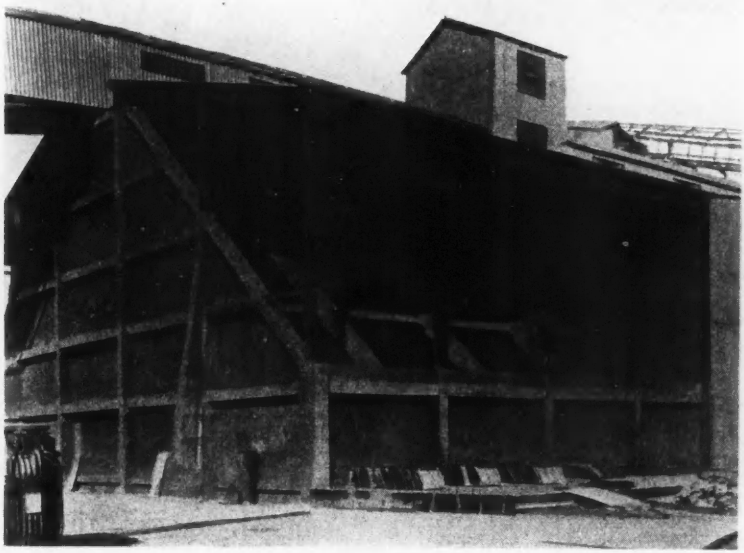
Coal Handling Plant and Gantry.

the top of the storage silo and discharge the coal into a top hopper provided with distributing chutes. This storage silo, which is of reinforced concrete construction, has a storage capacity of 1,000 tons in two compartments, one holding 750 tons of slack and the other 250 tons of duff.

The operation of this plant, which has a handling capacity of 100 tons per hour, is practically automatic and can be run by one man who places the loaded wagons on the tippler. The tippler is operated by one push button, which elevates, tips, and returns the empty wagon. As each empty skip reaches the level of the rotating feed-table the latter automatically begins to

discharge and fill the skip. When the skip is practically full its increasing weight operates a switch which shuts off the feed-table, and after a few seconds the full skip is hoisted to the top of the silo into the tip, and the same cycle of operations begins on the descending empty skip.

The coal discharges through openings provided with regulating feeds in the bottom of the silo on to a travelling belt. The slack and duff in any desired proportions feed into a cross-conveyor mixing-trough, which feeds through a roll crusher on to an inclined belt-conveyor which passes over and feeds into the coal hoppers of the four kilns on the firing floor platform. The coal from



Clinker Store.

each hopper passes through a cubimeter into a pulverizer, and an accurate record is thus kept of the coal consumption of each kiln.

On leaving the kilns the exit gases pass through dust-precipitation chambers on their way to the chimneys. The precipitation chamber for kilns Nos. 4 and 5 is a reinforced concrete structure lined with firebrick. It is divided into two separate compartments, one for each kiln; each compartment is hopper-bottomed and fitted with the necessary appliances for dust precipitation. The precipitated dust is discharged from the hopper bottom through self-closing valves into a trough provided with a scraper chain, discharging into a small mixing tank supplied with slurry. The mixed product is then pumped back into the 66-ft. storage mixer. The precipitation chamber directly adjoins the chimney leading into it by means of two rotary damper-doors so that

Cement Grinding Mills.

either compartment can be isolated while the other is working. The chamber connects with the outlets of the two kilns by a flue carried on concrete piers. The dust chamber for kilns No. 6 and 7 is similar in design, and is connected direct to the kiln outlets by short reinforced concrete flues.

The clinker from kilns Nos. 6 and 7 delivers from the recuperators into either of two cross shaking conveyors, which in turn deliver into either of two main shaking conveyors running parallel with the kilns. The clinker from the coolers of kilns Nos. 4 and 5 also discharges directly over and into these conveyors.

The combined clinker output from the four kilns delivers into either of two clinker elevators housed in a tower just outside the end of the kiln building. The capacity of each of these elevators is 65 tons per hour.

Grinding Mills.

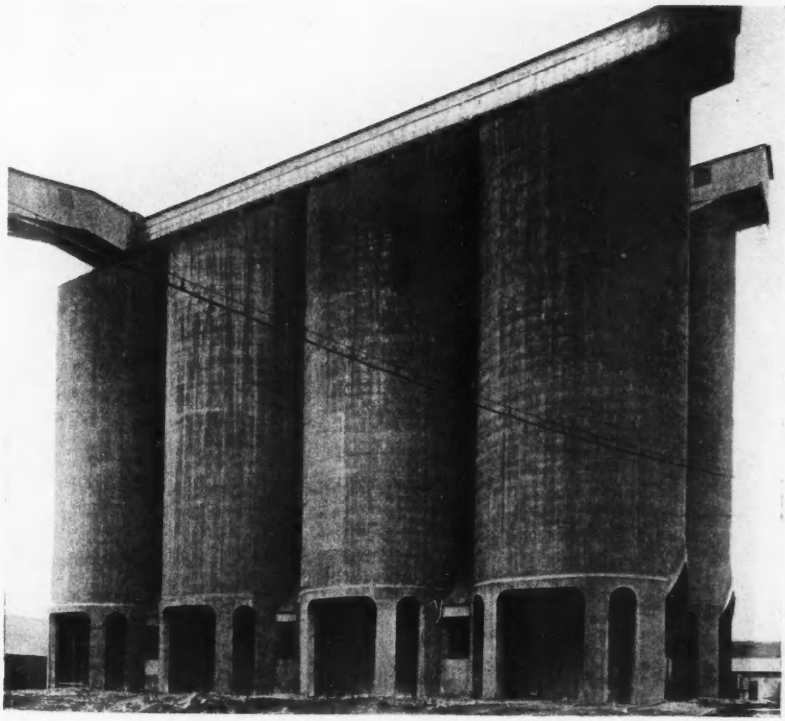
The clinker is ground in six compound tube mills. Each mill is 36 ft. long by 7 ft. 2 in. in diameter and divided by diaphragm plates into four grinding compartments. The capacity of each mill is 20 tons of clinker per hour. The mills are driven through a spur-wheel and pinion drive, each being connected by a coupling to a 750-h.p. motor. These motors, which run at 158 r.p.m., are of the self-starting auto-synchronous type working on a 3-phase 3,000 volt supply and arranged for unity power factor at full load.

The mills are fed from an overhead bin running the full length of the building and divided into six compound compartments, one to each mill; each

clinker compartment holds 200 tons and each adjoining gypsum compartment holds 50 tons. At the kiln end of the overhead clinker bins is a reserve clinker storage with a capacity of 4,000 tons. This is a reinforced concrete structure with retaining sides, and the floor on the ground level is divided along its centre by a partition wall separating the store into two equal compartments.

Clinker leaving the shaking conveyors at the coolers is elevated to the top of the elevator tower and delivered into either of two 20-in. wide troughed belt-conveyors. These run at the same level by an overhead gantry across to the top of the reserve clinker store and thence along the full length of the overhead clinker bins. Each belt is provided with a travelling tripper-gear running the full length of the bins, which deposits the clinker into any of the bins and both sides of the reserve store. The stored clinker from the latter is withdrawn through two chutes which deliver into an elevator discharging on to either of the conveyor belts and thence into the mill bunkers.

The grinding mill building is 140 ft. long by 114 ft. wide. One-half the building houses the six grinding mills (and storage hoppers) and the other



Cement Silos.

half, separated by a dust-proof concrete partition, is again divided into two divisions; one section houses the six 750-h.p. driving motors and the other is further sub-divided into a main substation equipped with distribution panels and switches, a substation power supply, and two air-washing chambers.

Adjoining the firing end of the kiln building is a reinforced concrete gypsum building having a storage capacity of 800 tons. Gypsum, which arrives by boat at the jetty, is loaded into standard 10-ton wagons, and after passing over a weighbridge passes by an elevated railway to the top of the gypsum store and unloads direct into the store beneath. The outlet, which is on the ground level, leads to a crusher. The crushed material falls direct from the crusher into either of the two clinker elevators and thence to the duplicate 20-in. belt conveyor which carries it to the gypsum bins over the grinding mills. Gypsum and clinker in the desired proportions are fed to the grinding mills by rotating feed-tables in the usual manner.

The output of ground cement from the six tube-mills discharges into either of two 18-in. diameter screw conveyors running under the mill floor. After elevation the cement discharges on to two 24-in. flat-belt conveyors housed in an inclined steel gantry, which extends from the tower, over the top of the grinding mill building, to the top of No. 1 and No. 5 silos. Here the two conveyors discharge into two cross conveyors, one running along the top of each line of silos.

Silos and Warehouses.

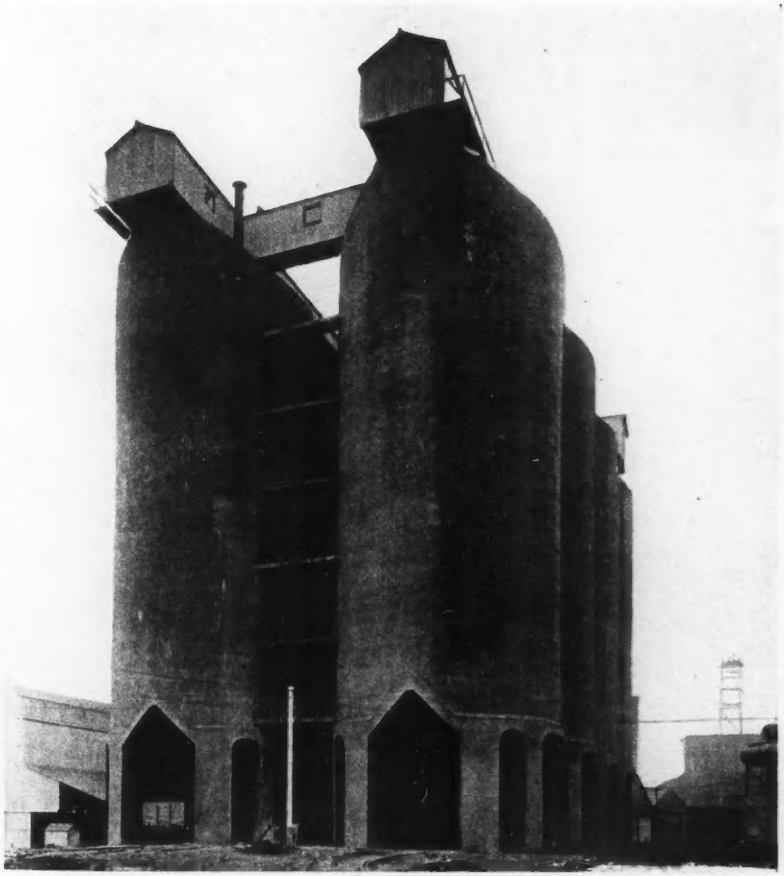
The silos, eight in number, each hold 2,000 tons of cement, giving a total storage capacity of 16,000 tons. The diameters are 32 ft. 6 in. inside by 96 ft. high from ground level. They are constructed of reinforced concrete and are arranged in two lines of four, each line having a tunnel 13 ft. wide to allow of the bulk wagons entering for filling. Each silo is divided by vertical walls into four compartments, one comprising half the total capacity, the other half being sub-divided into three. Platforms are arranged every 12 ft. outside the silos to allow of samples being taken of the contents.

The silos are filled from the cross-belt-conveyors through feed hatches in the top, separate feed hatches being provided for each compartment. Each compartment discharges through flexible pipe connections to bulk wagons in the tunnel below, and a compressed-air supply is arranged to facilitate the discharge. The bulk wagons, three in number, are of steel construction and totally enclosed, with a capacity of 25 tons each. They are electrically-driven from an overhead line, and supported on two bogies. The leading bogie is driven on each axle by standard tramway-type single-geared motors, the necessary controls being carried in an enclosed cab. The trailing bogie is not driven.

The two existing cement warehouses, capable of storing 6,000 tons of cement, will remain and be used for road and lorry trade and, in case of emergencies, to supplement the output of the packing plant on the jetty. Cement is delivered to these warehouses by two 24-in. wide flat-belt conveyors,

which in turn are fed from the conveyors over the silos. These conveyors, housed in an overhead steel gantry, discharge on to two existing 14-in. flat-belt conveyors running the whole length of the two warehouses which discharge on to the flat floor. By means of two screw conveyors below floor level the stored cement is then conveyed to a 2-valve packer and packed in sacks and casks. The packed material delivers on the one hand direct into a loading bay connected by a concrete road to the main road and on the other to a railway siding. The steam and petrol lorries and trailers used for road delivery are housed in one bay of a new building, the other bay housing the railway locomotives.

Details of the jetty will be given in a later number.



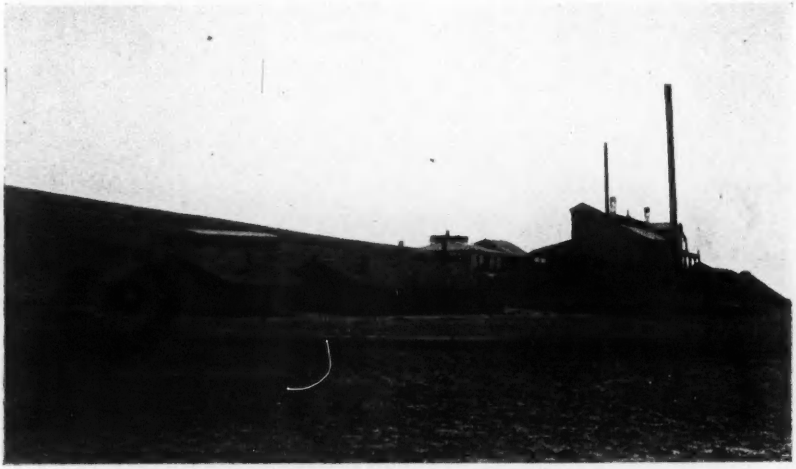
Cement Silos showing Railway Tunnels.

The Highest Cement Plant in the World.

By A. REID-KELLETT.

THE highest cement plant in the world is that of the Sociedad Boliviana de Cemento (Bolivian Cement Company), situated in the Republic of Bolivia at an altitude of 14,500 ft. above sea level. The plant, to produce cement by the dry process, was to have had a capacity of 6,000 barrels per month, and it was estimated that the plant would be able to produce sufficient cement to fill Bolivian requirements at a price that would eliminate foreign cement altogether.

The rock, clay and gypsum are crushed by a No. 6 McCully gyratory crusher and elevated to a three-compartment bin from which the rock and clay are drawn and mixed in the desired proportion in hopper scales. The mixture is



The Bolivian Cement Company's Works: 14,500 ft. above Sea Level.

then elevated and fed to an Allis-Chalmers 30 ft. by 4 ft. dryer using crude oil fuel. From the dryer discharge the mixture is elevated to a bin which feeds a 6 ft. by 15 ft. Compeb mill. The powdered material is then elevated to a screw conveyor leading to a bin from which it passes to a feeder regulated by a Reeves' "speeder." It is then elevated to the spout leading to the kiln, which is 100 ft. by 7 ft. This kiln is also oil fired.

Power for the plant is provided by a Sulzer-Diesel four-cylinder four-cycle engine rated at 520 h.p. at sea level, but giving only 70 per cent. of this h.p. at the altitude stated.

The clinker is elevated from the clinker pit to the pile by means of a continuous bucket elevator set at an angle of 45 degrees. The operation of the plant is intermittent, with alternate periods of burning clinker and alternate

(*Continued on page* 109.)

(*Continued from page* 108.)

periods of grinding. After grinding the clinker, the resulting cement is elevated and conveyed by means of a screw conveyor to four storage bins from which it is drawn through spouts for sacking by hand.

The raw materials available for the manufacture of cement are excellent, and analyse as under:

	Limestone. Per cent.	Clay. Per cent.
SiO_2	5.03	64.70
R_2O_3	0.61	23.65
CaO	53.57	1.20
MgO	0.71	1.93
SO_3	0.04	0.01
Loss in calcination ...	40.10	5.23

Separation of the iron and alumina in the clay showed Al_2O_3 19.39 per cent. and Fe_2O_3 4.26 per cent.

When the plant commenced operations it was found that when the mix was passing through the dryer at least 80 per cent. of the clay was carried off by the draught in the stack and this was corrected.

The results obtained from this plant were not up to expectations, and were a disappointment to the Bolivians, who are keen to see the establishment of national industries in their country. Alterations are, however, being made in the plant, and it is to be hoped that these changes will result in success. The consumption of cement in Bolivia is not large but it is expanding, and should double itself in a very short time if the national factory can produce good cement at a reasonable cost.

Green Island Cement Company's Developments.

The Green Island Cement Co., Ltd., of Hong Kong, has recently decided to renew its cement plant. The Company was founded in 1889 at Macao, where some Schofer kilns were installed. In 1899 an extension was made by the erection of further Schofer kilns in Kowloon, Hong Kong, and in 1905 a dry-process rotary plant was added. Various alterations and improvements have been made since then, and now an entirely new 100,000-ton plant has been specified, with provision for duplication at a not far distant date. The general managers of the Company are Messrs. Shewan, Tomes & Co., of Hong Kong, and their consulting engineer is Mr. Henry Pooley, Jun., B.Sc., Assoc.M.Inst.C.E., of 2, Verulam Buildings, Gray's Inn, W.C.1.

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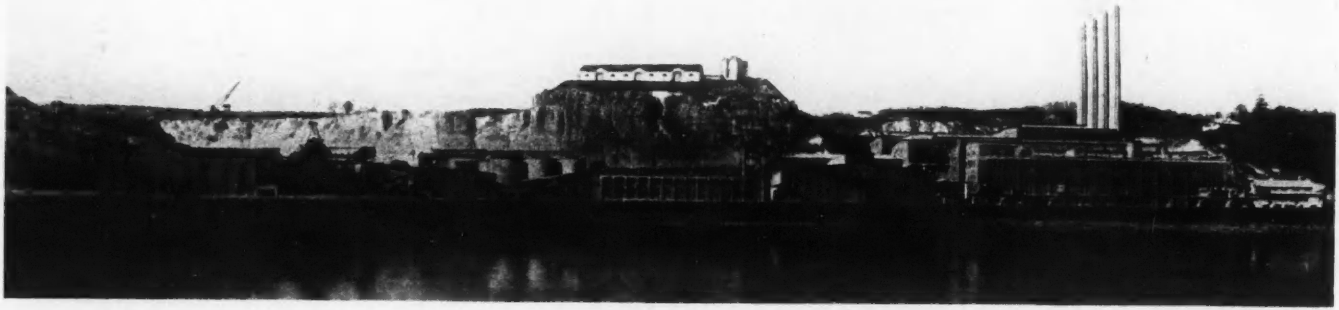
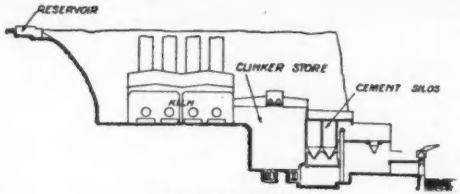
More recent work:—National Cement Co. (3,000 bbls. daily), Montreal, Que., Canada; Keystone Portland Cement Co. (3,000 bbls.), Bath, Pa.; Standard Lime & Stone Co. (1,200 bbls.), Martinsburg, W. Va.; Republic Portland Cement Co. (3,000 bbls.), San Antonio, Texas; Raymon Ferreyra (240 tons hydrated lime), Cordoba, Argentine.





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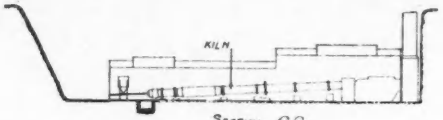

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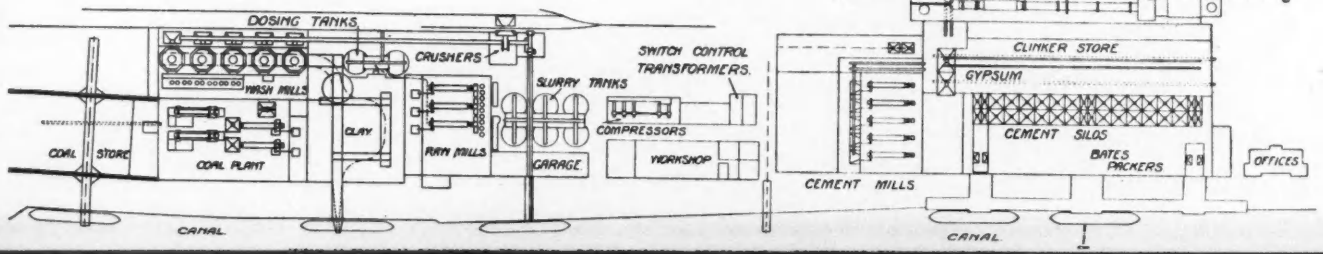
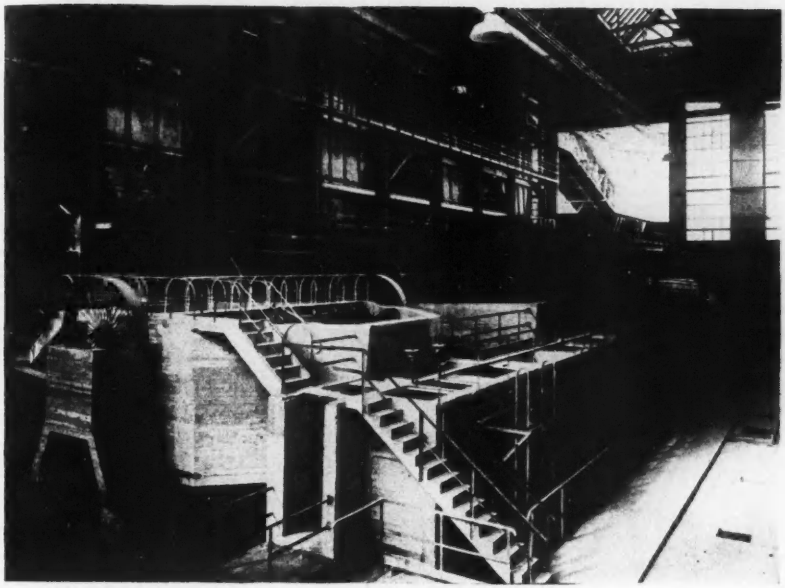


New Cement Works at Maastricht, Holland.

By HENRY POOLEY, Jun., B.Sc., A.M.Inst.C.E., A.M.I.Mech.E., F.C.S.

Holland contains very little material suitable for Portland cement manufacture, but at Maastricht there is a large deposit of calcareous marl which was used in Roman times for building purposes. A Portland cement works has just been completed here, known as the " N.V. Eerste Nederlandsche Cementindustrie," or " Enci." The Maas canal runs by the side of the deposit and the works is conveniently situated for cheap transport. The hill of marl



Wash Mill House.

slopes almost to the edge of this canal; therefore the site is narrow, and a rather original lay-out has been necessary. The buildings occupy a frontage of about 450 metres along the canal bank, and the works has been fitted into the place available in a series of steps in the side of the hill, as illustrated by the sections shown.

The present capacity of the " Enci " plant is about 4,800 tons of clinker per week from four kilns, although it is hoped to increase the output to just over 7,000 tons, and, as will be noticed from the lay-out, extensive provision has been left for an increase in grinding capacity. Also, the crushing plant will supply 5,000 tons of marl per week more than is required by the works,

for shipment to another plant. As the raw materials are soft calcareous marl and clay the wet process was installed. Nearly all the cement-making machinery was supplied by Polysius, exceptions being the diggers made by Menck and Hambrock; electrical dust-precipitation plant by Lurgi; Fuller-Kinyon coal pumps; and Bates packers.

Quarry.

The overburden is fairly thick and is removed by a caterpillar grab and narrow-gauge railway. The face of the quarry is about 50 metres high, but even so the floor is still about 16 metres above the canal level. The marl is quarried by blasting in the upper sections, and then by diggers on caterpillar tracks on the quarry floor. The navvies load the marl into trucks which are moved by locomotives to the crushing plant, about 100 metres away at present.

Primary Crushing.

The marl is tipped direct from the trucks into feeding bins. To ensure a uniform flow of material the bins are emptied by " grizzley-bar " type feeders, which feed the material to the crushing rolls. At first the crushing was done by a hammer mill (Zet type) while the main crushing plant was being installed. The Zet crusher is still retained to deal with the marl which is shipped from the works. The material from this machine drops on to a troughed belt, 800-mm. wide, which loads the barges alongside by means of a movable chute.

The main crushing plant consists of a single roller mill which takes pieces up to 800 by 500 by 500 mm., reducing to about 200 mm. size, and is driven by a 150-h.p. motor. It discharges on to a second troughed belt 1,200 mm. wide and 99 metres long. This belt, running on a slope, lifts the marl to the hoppers over the washmills. The main belt discharges on to a secondary belt for feeding the washmill hoppers. The relative position of the secondary belt is adjustable and the belt is reversible, while the driving motor is also used for shifting its position. In this way the material can be discharged into any of the washmill hoppers, and the secondary belt is only half as large as would have been necessary had its position been fixed.

Washing, Raw Grinding and Mixing.

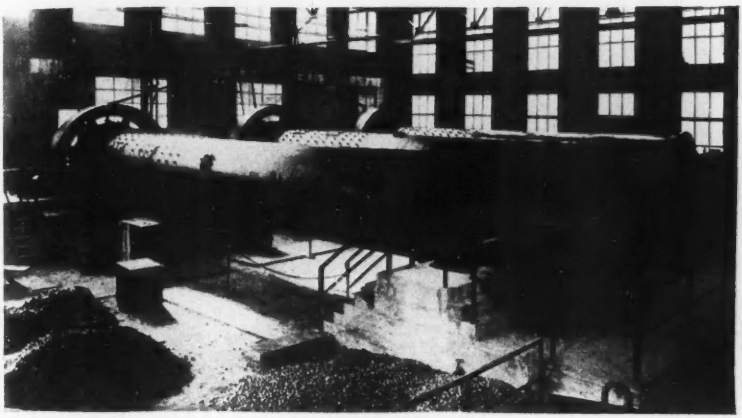
There are five steel wash-mill hoppers, 11 by 4.5 metres section and 10 metres high, with rotary feed-tables of 2,500-mm. diameter which feed the marl to five washmills below. The washmills are 9 metres in diameter, each requiring a 70-h.p. motor, and can be fed with either marl or clay. The deposit contains some flints, which are removed from the washmills from time to time. Clay is landed from barges by means of a grab and overhead runway, as shown on the plan, and may be fed direct to the washmills or dumped on the clay store. The same runway can reclaim the clay from the dump for feeding the washmills.

Clay is washed separately, and clay slurry pumped by means of centrifugal

pumps to one or other of the marl washmills, so that a mixture of the two ingredients is obtained in the washmills.

The slurry is led through concrete troughs to four groups of " pressors," or air-operated slurry pumps. Each group of pressors consists of two pressor tanks, which are operated automatically in such a way that while one is discharging the other is filling with slurry. Each pressor has a measuring device attached, so that the quantity of slurry passing can be checked at this point. The slurry is discharged in this way to two steel slurry tanks, each 16 metres high and 9 metres in diameter, which are air-agitated by the usual Polysius system. From these tanks the slurry is pumped by centrifugal pumps to the feed tanks over the raw mills.

At the moment there are three raw mills, but provision has been made for the installation of two more in due course. These mills are of the combination ball and tube mill type, and contrary to the usual Polysius practice are



Slurry Mills.

provided with trunnion bearings. The mills are 13 metres long by 2 metres diameter, and have three compartments in which the grinding media are carefully graded. The mills deal with sufficient slurry for the kilns now operating, although without standby. They are each operated by a 425-h.p. motor, and grind the slurry to about 5 per cent. residue on the 180-mesh sieve. The drive of the mills is through reduction gearing, torque shaft, pinion, and girth gear.

From the mills the slurry flows into pressors which transport it to one or other of six steel slurry storage tanks, 16 metres high and 9 metres in diameter. The final mixing is done in these tanks. All the mixing is done by compressed air and is regulated by the Regulex valve which governs the frequency of the air blast and the rotation in which the tanks are agitated. It can be set to miss one or more of the tanks, and so forth, being quite automatic in operation when once set. From these tanks the slurry is

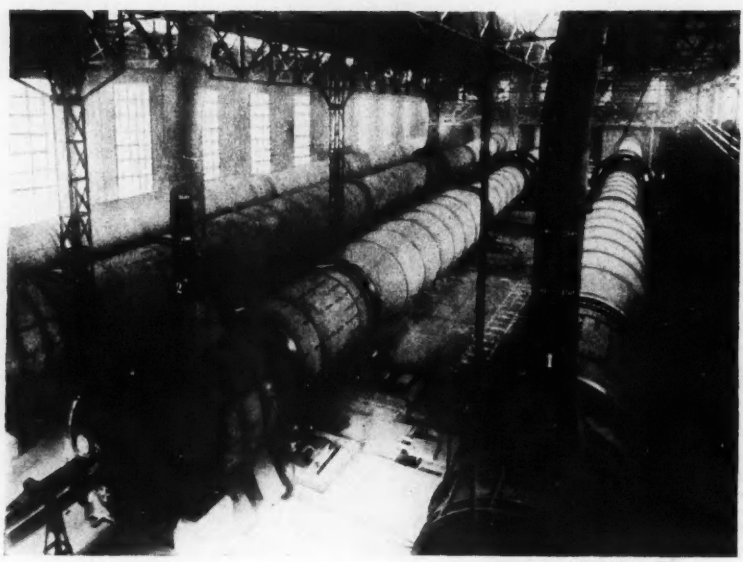
transported by pressors either to an intermediate slurry tank (8 metres high and 5 metres in diameter) in the kiln house, or direct to the kiln feed tanks. It is interesting to note that these tanks are about 325 metres from the last-named pressors and 25 metres above them. To compress all the air necessary for slurry transport, slurry agitation, cement pump, and, in fact, for all purposes on the works, there are five compressors, three taking 320 h.p. and two 182 h.p.

One kiln-feed tank serves two kilns, and from it the slurry flows over a notch and is introduced into the kiln by the simple gravity method. Naturally, the head of slurry in the feed tank is kept constant. A vernier pointer can be adjusted to touch the stream of slurry flowing over the notch, and the calibration gives the quantity of slurry passing.

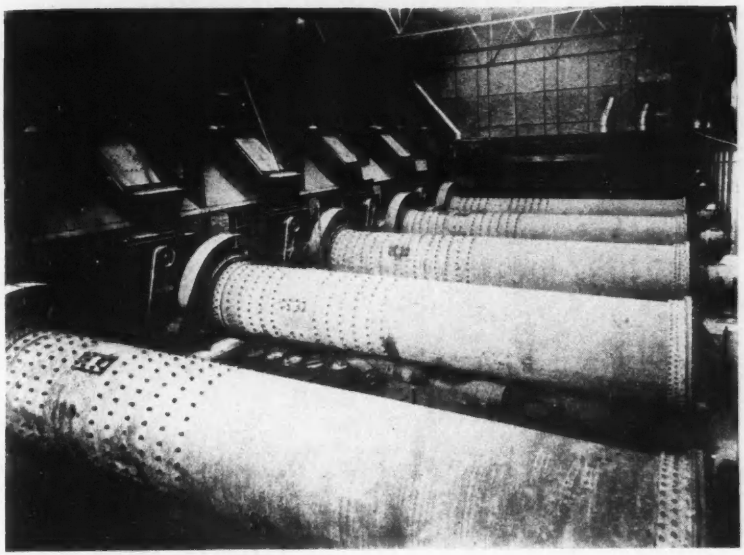
There are two smaller tanks at the upper end of the kiln, one alongside each of the slurry feed tanks. These contain the dust extracted from the flue gases, both in the flues and in the electrical dust-precipitation plant. This dust is collected by means of worm conveyors running in troughs under the hopper-shaped bottoms of the flues, and elevated by means of an ordinary totally-enclosed bucket elevator. It is returned to the kilns with the in-going slurry by means of double-screw extractors. As indicated previously, there is an electrical dust precipitation plant which deposits what dust remains in the gases after they have passed through large dust chambers.

Kiln Department.

At present four kilns are installed, each having a capacity of 1,200 tons



Kiln House.



Cement Mills.

of clinker per week. The overall length of the kilns is 70 metres including the cooler, which is 10 metres long. The diameter of the cooler is 3 metres, while the burning zone of the kiln is 3.6 metres. The diameter of the rest of the kiln is 2.7 metres. The arrangement is of the improved " Solo " type, in which the drying, decarbonising, clinkering, and cooling are all performed in the one cylinder. The construction is of the usual Polysius massive type. There are six riding rings, and the girth gear is attached to the shell through the usual spring attachment. The cooler, as stated, is attached to the kiln in prolongation. In the old " Solo " type the clinker continued its course through the inside of the cooler. In the improved type there are a number of ports on the line of junction of the kiln and cooler, and the clinker falls through these and continues its passage in six compartments fitting closely around the shell. This greatly increases the cooling effect, and improves on the older type in that there is now a clear view of the firing zone, not interfered with by a curtain of cascading clinker. Special arrangements are made in the upper end of the kiln to split up the stream of slurry so that the water can be more rapidly dried out. Also, special means are employed in the cooler to assist in the transfer of all possible heat from the clinker to the incoming air for combustion.

The kiln is furnished with automatically-lubricated water-cooled roller bearings, and is driven by a 50-h.p. motor and gearing, there being no belts. Over each burning platform is a steel bin of 45 cubic metres capacity to which

powdered coal is supplied from the separate coal-grinding plant. The coal is extracted from these by double worm extractors and fed to the burner pipe. The speed of the supply of coal can be governed by a variable-speed motor which drives the extractors. The fan required to inject the coal dust is driven by a 30-h.p. motor.

Clinker Storage and Cement Mill.

The clinker coming from the coolers falls on to a bucket conveyor 600 mm. wide and 39 metres long running in a tunnel under the burning platform. This conveyor is duplicated, as will be seen from the plan. There are two single-roller mills of 1,100-mm. diameter and 900-mm. width at the discharge end of the clinker conveyors. The clinker is taken up by a totally-enclosed bucket-type elevator to a belt 700-mm. wide and 90 metres long running over the clinker store. A second belt conveyor of similar dimensions is installed as a standby. As the temperature of the clinker is low these belts are of rubber, and they are fitted with throw-off carriages to discharge the clinker at any point over the store. One wall of the clinker store is formed by the natural face of the cliff, as will be noted from the section, and the other wall by the cement bins. The height of the belt conveyors over the floor of the clinker store is 24 metres, the length of the store is 100 metres and the width 20 metres.

The gypsum is unloaded from barges in the canal by the overhead runway shown, and is stored at one end of the clinker store. Running beneath the clinker store are two further rubber belts which take the clinker and gypsum to the bins over the cement mills through the medium of an elevator.

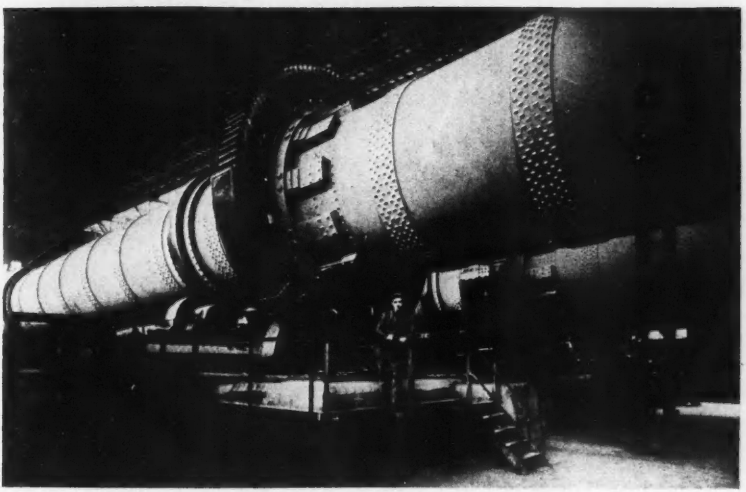
Five cement mills have been installed, but there is provision for a further five mills, as may be seen from the plan. The mills are 12 metres long and 2 metres in diameter, and have three grinding compartments. In common with the other mills in the works they have trunnion bearings, and are driven by high-speed motors through reduction gearing, torque shaft, pinion, and girth gear. The mills are coupled to 425-h.p. motors. Complete dust collection plant is installed in this place, consisting of two suction filters of 96 bags each with suitable fans.

The cement is conveyed by worms and elevators into hoppers over the new type Polysius " Cera " cement pump. This pump is interesting in that it is claimed to be more economical in power than similar pumps on the market for this purpose. From the hopper over the pump the cement falls through a breeches-chute to one or other of two tanks situated directly over the pumps. The outlets from the breeches-chute are controlled by an air-operated valve, and when one tank is filling the other is emptying. At the bottom of each tank is a cellular wheel, operated from outside by a 7-h.p. motor through a chain. The wheel extracts the cement from the tanks and drops it into a pipe to which compressed air is introduced in the direction of flow. The compressed air forces the cement along the pipe to the silos. By a connection between the cement conveying pipe and the top of the tanks, pressure is regulated on the cement in the tanks.

Cement Silos and Packing.

The cement is pumped to one or other of the 24 large silos, each 5 metres by 5 metres section and 17.5 metres high. In the centre of the row of bins, and at both ends, smaller packing silos are provided. The packing bins, as well as the larger ones, are filled by means of the cement pump described. Extraction of the cement is done by movable double-screw extractors driven by variable-speed motors, and the further conveyance of the cement is done by worm conveyors and elevators.

The packing house, in addition to the ground floor, has three other floors, all connected by a lift. On the ground floor are all the mechanical and pneumatic conveying gear and the loading platform for cement to road lorries. On the first floor are four double Bates packers and the loading platform for



Drive for Kilns.

cement to be shipped by barge. On the second floor are two continuous bag-cleaning machines of 2,500-mm. diameter by 7.5 metres long, and the sack-repairing department for jute bags, some of which are still used for cement packing. On the top floor there is a suction filter of 40 bags for collecting the dust from the bag-cleaning and repairing plant.

Cement is loaded into barges by crane operating on the overhead staging indicated in the drawing. Each crane can lift 30 bags of cement of 50 kg. per bag.

Coal Plant.

Coal is landed from barges by a grab crane and overhead runway on to the coal store. It is reclaimed from there by underground troughed belt conveyor. This conveyor takes the coal to two elevators which in turn feed two dryers, 16 metres long by 1,800 mm. diameter, driven by 20-h.p. motors.

The furnaces of the dryers are equipped with automatic coal feed, and each dryer is fitted with electrical dust-precipitation plant. The dried coal is taken into two bins by elevators and thence passes through automatic weighers and rotating feed-tables to the mills.

The coal mills are of the combination ball and tube mill type and have three compartments. Two mills are installed at present, but provision is left for a third. The mills are 12 metres long by 2 metres in diameter, and are driven in the same way as the other mills on the works by high-speed motors and reduction gearings. As before they are of the trunnion bearing type, and a 425-h.p. motor is coupled to each. The coal is taken by means of worm conveyors and elevator to a steel storage bin in the coal mill, and from this bin it is fed to two 6-in. Fuller-Kinyon coal pumps which transport the material to the bins over the burning platform of the kilns. Complete dust-collection plant is also installed, comprising a suction filter with 96 bags and fan of 1,600 mm. diameter.

In general, all the buildings are of steel-frame and concrete construction. The laboratory is well equipped, and no expense has been spared in any department of the works. Power is supplied from outside, and transformed at the station shown on the plan.

The works has only just been put into full operation, the first two kilns having been started in September last. It is not therefore possible to give the actual performance of the various units, but there is no reason to doubt that they will conform to expectations.

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Estimation and Analysis of Raw Materials for Portland Cement.

By A. C. DAVIS, M.I.Mech.E., M.Inst.C.E.I., F.C.S.

(*Works Managing Director, Associated Portland Cement Manufacturers, Ltd.*)

BEFORE the succeeding stage of the manufacture of Portland cement is proceeded with it will be seen that the calcareous and argillaceous ingredients are mixed so as to give the exact and necessary proportion of calcium carbonate to silica and alumina. It is necessary, therefore, to be chemically accurate in the estimation of the proportions of these constituents contained in the raw materials, and no effort on the part of the manufacturer and no scientific operation can bring the resultant cement up to the standard it might otherwise have attained if the proportioning of the ingredients has been inaccurately carried out. The manufacturer has to exercise a constant check on this section of the process to ensure that the raw material mixture is of normal constitution, and methods must be adopted of accurately testing the mixture, particularly for calcium carbonate, with speed and facility.

It will be gathered that the raw material containing lime (the principal constituent in Portland cement) may be in the form of soft chalk or a hard crystalline limestone, or one of the many grades of calcium carbonate between the two, as well as, in rare cases, slag or alkali waste. Soft white chalks are usually very pure carbonate of lime but contain much water, while hard limestones often contain in a natural state as much as 99 per cent. carbonate of lime.

The clay (containing the silica and alumina) varies almost as much as the lime materials, *i.e.*, from soft river mud to hard shales or slate. The chalk and limestone generally contain few impurities, but the clay is apt to contain magnesia, sulphur, and alkalies, the presence of which must be kept within certain strictly-defined limits. The smaller the quantity of these foreign substances present in the raw material the better.

It is necessary, therefore, first to determine accurately the exact composition of the materials, as some substances are injurious to the finished cement and others simply increase the bulk without any appreciable benefit.

The sampling of raw materials to be used in the manufacture of Portland cement is therefore in itself an important operation calling for great care, and is the art of extracting from a large bulk of material a small portion which will fairly represent the character of the whole bulk. The five principal ways of sampling are:

(1) Fractional selection.
(2) Quartering.
(3) Channeling.
(4) Split shovelling.
(5) Riffling.

The most common method of sampling is by quartering, and is shown in Figs. 1, 2, and 3.

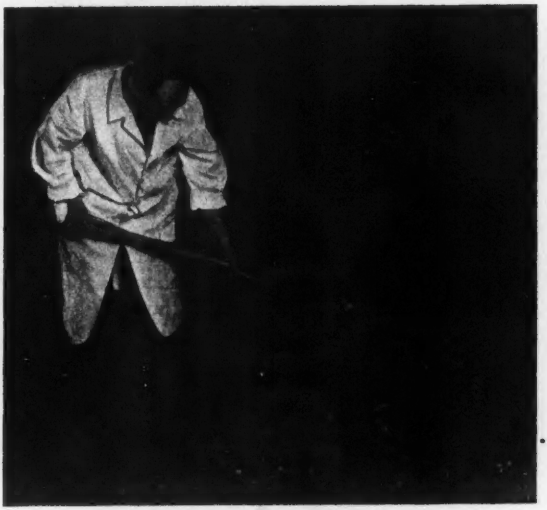


Fig. 1.—Material First Piled into Cone.

Fig. 2.—Flattening "Cone" Evenly into "Pancake."

By whichever means it is carried out, the work should be done thoroughly, as the errors incidental to the process of chemical analysis are somewhat insignificant compared with the errors involved in bad sampling. Having obtained the sample it should be ground, passed through the 180-mesh sieve, dried at 105 deg. C. and bottled ready for use.

Magnesia, nearly always present in the raw material, is generally considered harmful if it amounts to more than 4 per cent. of the finished cement, and is kept within this limit in Great Britain. The effect of excess of magnesia in cement is to cause expansion, but the exact chemical action has not yet been definitely explained. Some experts consider that magnesia, though possessing marked hydraulic properties when ignited alone, yields no hydraulic products when heated with silica, alumina, or clay, and probably plays no part in the

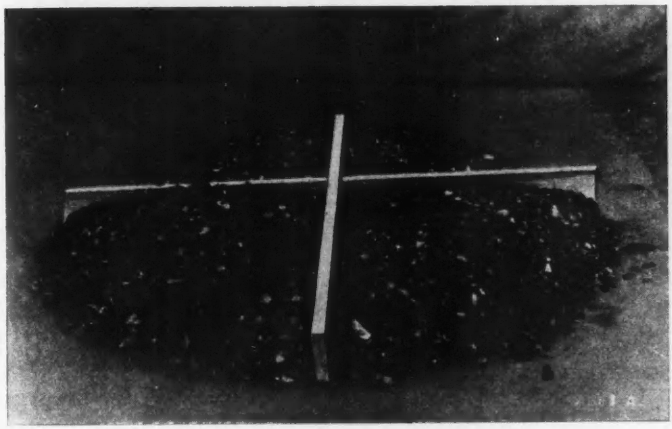


Fig. 3.—Quartering "Pancake."

formation of the cement. It is incapable of replacing lime in cement mixtures, the composition of which should be calculated on the basis of the lime only without regard to the magnesia present.

Nearly all clays contain sulphates in small quantities; the presence of even the smallest quantity is injurious in a theoretical sense, but less than 2 per cent. may not be noticeable in practice. In the finished cement it may appear as sulphate of lime, commonly known as gypsum or plaster of Paris. This substance forms, in the presence of lime set free during setting of the cement, with the aluminates usually found in cement, a crystalline compound which occupies a much larger space than the aluminate and sulphate of which it is composed. For this reason any considerable quantity of sulphate will cause expansion of the whole mass of the cement, tending to produce cracks and materially weaken the finished concrete.

Should the cement contain no alumina the dangerous compounds are not formed, but this is a most unusual condition with raw materials for Portland

cement. Various tests have shown that sulphate of lime up to about 2 per cent. increases the strength of cement, but with a large excess the strength of the sample decreases owing to expansion or " blowing " caused by the formation of the crystalline compounds described.

Oxide of iron appears in most normal Portland cements in small quantities, and is not objectionable except for the colour which it imparts to the cement when its amount is considerable. Materials free from this compound are, however, called for when a white Portland cement has to be produced.

There are a few other substances which occur in even a good cement, but they have little or no chemical action and unless present in considerable quantity need not be considered.

An increase in the proportion of clay (with the necessary lighter burning) tends to make the product quick-setting and to reduce tensile strength at short periods, thus approaching more nearly the qualities of natural cement.

Excess of lime, on the other hand, produces expansion and cracking. This defect may, however, be unfailingly recognised by " long-time-cold " pat tests or by the boiling tests, which will be dealt with later. Failure in these tests is caused, however, much more frequently by imperfect grinding of the raw materials than by too high a proportion of lime.

With improved grinding of the raw materials a steady advance in the proportion of lime contained in Portland cements has taken place. Thirty years ago Portland cements usually contained 56 to 60 per cent. of lime (CaO) ; now, 64 to 66 per cent. is frequently reached.

METHODS OF ANALYSIS.

The methods usually adopted for analysing the raw materials and the mixture of the raw materials when prepared for manufacture are as follows:—

Calcareous Materials, Limestones, etc.

If there is more than 5 per cent. insoluble silica, etc., it is safer and quicker to analyse by the fusion method, as for clays; if under 5 per cent. proceed as follows:—

Weigh one gramme of the sample into a porcelain dish; swill round with water; add 20 c.c. of strong hydrochloric acid; evaporate to dryness on hot plate, carefully at first to avoid spitting; then bake for one hour at full heat of plate; remove, and when dish is cool enough to hold in hand add 20 c.c. of strong hydrochloric acid; leave for 15 minutes, warming very gently if necessary until all red colour of the iron salts has disappeared. Dilute with water, filter, and wash well. Dry the separated silica; burn off and weigh the silica and insoluble in a platinum crucible; then treat with hydrofluoric acid as follows:—

Add 20 to 30 c.c. of the acid and 1 c.c. of strong sulphuric acid and evaporate to dryness over a low flame; repeat a second time if considered necessary, then heat strongly in the muffle for half an hour and weigh. The loss in weight is the true amount of silica; any residue is extracted by fusion with six or seven

times its weight of potassium bisulphate, cooled, dissolved in a small quantity of 10 per cent. hydrochloric acid and added to the main solution which is then made up to 500 c.c. and divided into two portions. In one portion ferric oxide and alumina, lime, and magnesia are determined; in the other ferric oxide.

Ferric Oxide and Alumina.—The solution is placed in a porcelain dish, heated to boiling, a few c.c. of bromine water added, then 50 per cent. solution of ammonia added very slowly until solution is neutral, 2 c.c. in excess added, and the mixture boiled for two minutes. The precipitate is filtered off, washed twice and then washed back into the dish, dissolved in a few c.c. of hydrochloric acid and precipitated as before, and filtered, catching the filtrate in the same beaker as the first time. This precipitate should be well washed and then dried, burnt off, and weighed.

Ferric Oxide.—The solution is placed in a porcelain dish, treated and precipitated as for the ferric oxide and alumina (only one precipitation being necessary), filtered, and washed. The precipitate is dissolved in hydrochloric acid, heated to boiling, and reduced with stannous chloride. When it is cool 15 c.c. of saturated solution of mercuric chloride are added, allowed to stand for 10 to 15 minutes, and titrated with a standard solution of potassium dichromate.

Lime.—To the combined filtrates from double precipitation of the iron and alumina add 30 c.c. of 50 per cent. solution of ammonia and bring to boiling; then add 40 c.c. of a saturated solution of ammonium oxalate, boil for five minutes, and allow the precipitate to settle. Decant as much of the clear solution as possible through a filter paper, keeping the precipitate in the beaker. Now dissolve the precipitate in dilute hydrochloric acid and boil, re-precipitate with ammonia and ammonium oxalate, and allow the precipitate to settle. Filter through the same filter paper, allowing the filtrate to mix with the first one. Wash the precipitate with warm water, thoroughly dry, burn off in platinum crucible, ignite gently until all carbon is burned off, then strongly ignite in the blast lamp until the weight is constant. The calcium oxalate is thus reduced to oxide and weighed as such.

Magnesia.—The filtrations from the lime are evaporated to small bulk by boiling down in a porcelain dish. When the liquid has been reduced to as small bulk as possible on the burner it is taken to complete dryness on the hot plate with the addition of 50 c.c. of nitric acid to destroy the ammonium salts. When cool, take up with dilute hydrochloric acid, neutralise with ammonia, and filter off any precipitate. An excess of ammonium phosphate solution is added, viz. about 5 c.c. of a saturated solution together with 20 c.c. of strong ammonia and the solution stirred briskly for about five minutes and allowed to stand overnight. The precipitate is then filtered off and washed with cold diluted ammonia solution (10 per cent.). The precipitate is then dried, ignited (first gently, afterwards in the blast lamp), and weighed as magnesium pyro-phosphate.

Sulphuric Anhydride.—One gramme of the powdered material is boiled with 50 per cent. hydrochloric acid solution, filtered, and washed. The filtrate is

raised to boiling, 10 c.c. of a solution of barium chloride is added, and the whole boiled for a few minutes. The precipitate of barium sulphate is allowed to settle overnight, filtered, washed well with warm water, ignited, and weighed.

Loss on Ignition.—One gramme of the powdered material is weighed into a platinum capsule, placed in a cold muffle furnace (which is lighted and heated gradually to full heat and left for one hour), cooled, and weighed. To correct the loss, for gain or loss of sulphuric anhydride due to treatment in the muffle, the ignited material is transferred to a porcelain dish and boiled with 50 per cent. hydrochloric acid, the insoluble portion filtered off and the sulphuric anhydride determined in the filtrate as before and any necessary correction made to loss on ignition.

Total Sulphur and Sulphuric Anhydride.—One gramme of the material is placed in a porcelain dish, swilled round with water, 2 c.c. of pure bromine added, allowed to stand for 5 to 10 minutes, then 10 c.c. of 50 per cent. hydrochloric acid added, the whole boiled until all bromine has disappeared. The insoluble matter is then filtered off, the filtrate is raised to boiling, and the barium sulphate precipitated as before. After standing overnight the precipitate is filtered off and treated in the same way as in the sulphuric anhydride determination. Any excess in weight of barium sulphate thus obtained over that from the sulphuric anhydride determination is calculated to sulphur.

Analysis of Argillaceous Materials, Clays, etc.

One gramme of the sample, together with 7 grammes of fusion mixture, are weighed into a platinum crucible, heated gently at first over a Bunsen flame, then ignited over a blast lamp to quiet fusion. Allow the crucible to cool below redness, then place upright in cold water to induce rapid cooling so causing the melt to leave the crucible. Now place the crucible in a porcelain dish with 40 c.c. of strong hydrochloric acid and 20 to 30 c.c. of hot water, and digest until the melt is all dissolved. Take out the crucible and thoroughly wash. Evaporate to dryness on a water bath and when dry leave for one hour on the water bath. Add 50 c.c. of strong hydrochloric acid and digest for 15 minutes. Remove from water bath, dilute with hot water and filter off the silica, catching the filtrate in a 500 c.c. graduated flask. Wash twice. Transfer the solution back to the dish and take to dryness on the water bath a second time. (While this is being done wash silica thoroughly, catching the washings in the graduated flask.) When dry, leave for one hour, add 50 c.c. of strong hydrochloric acid, and take up and filter off any silica as before, catching the filtrate in the same 500 c.c. graduated flask, and wash thoroughly.

The two precipitates are then dried, burned off in a platinium crucible gently at first to remove the carbon, then in a muffle furnace for one hour, cooled in a desiccator, and weighed. The precipitate should then be treated with hydrofluoric acid, any residue from this treatment being fused with potassium bisulphate dissolved with hydrochloric acid and added to the main solution in the 500 c.c. flask. This solution is then made up to 500 c.c. with cold water and

separated into two parts as before. In one portion ferric oxide and alumina, lime, and magnesia are determined; and in the other ferric oxide.

Rapid Determination of Lime.

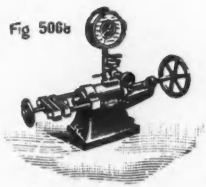
The following is a useful method for determining lime in cement or in calcareous materials containing less than 5 per cent. of insoluble silica, etc., and is useful as a check on a gravimetric determination. Weigh ½ gramme cement into a 600 c.c. beaker, swill round with water, add 10 c.c. H.C.L., boil until solution is complete, neutralise with 50 per cent. ammonia solution from a burette using a few drops of methyl orange as indicator, add 10 c.c. oxalic acid solution (95 grammes per litre), boil, and while boiling add 40 c.c. boiling ammonium oxalate solution (50 grammes per litre). The mixture is boiled for five minutes, allowed to settle for ten minutes, filtered, washed thoroughly two or three times by decantation, and (when all precipitate is in filter paper) washed until quite free from excess of ammonium oxalate. Wash precipitate from filter back into beaker, fold up filter paper and lay on the side of beaker. Add 25 c.c. of 25 per cent. sulphuric acid, heat to boiling, titrate with potassium permanganate solution (6 grammes per litre) adding filter paper at end, mixing thoroughly into solution to ensure all precipitate is acted upon. At the same time treat in exactly the same way a known weight of pure calcium carbonate (a useful amount to take is 0.55 gramme), then a simple calculation gives the lime content of the cement:

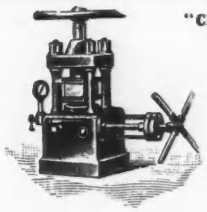
0.55 gramme $CaCO_3 = 0.308$ gramme CaO.

$$\therefore \text{CaO in cement} = \frac{\text{No. c.c.'s permanganate used for cement} \times 0.308 \times 200}{\text{No. c.c.'s permanganate used for pure } CaCO_3}.$$

The standard permanganate solution should be kept in a dark coloured bottle in a dark cupboard when not in use; also it should be made at least a fortnight before use.

(*To be continued.*)

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New Method of Hardening Steel.

(CONTRIBUTED.)

THE abrasive nature of Portland cement necessarily brings in the train of its manufacture numerous special problems connected with the wearing of vital parts of a machine. Various hardening and welding processes have been on the market for some years past claiming to achieve this desirable end, but generally speaking, none of the systems tried by the writer has been wholly successful.

The process about to be described is one by which steels can be surface hardened at a low temperature by the absorption of nitrogen from ammonia gas. It is known in this country as "Nitration," and has been used in America for some time under the name of "Nitriding." Steels of a special alloy or analysis are used in the process, and it must be admitted that some surprising and outstanding results have been obtained.

Briefly the process consists of subjecting finished machined parts of special steel to the action of ammonia gas at a temperature of 500 deg. C. for a period of time necessary to produce the depth of case required. The ammonia is dissociated, and part of the nitrogen so formed passes into solid solution in the outer layers of the parts, forming a case harder than any previously known in metallurgy. (The Brinell hardness is 900 to 1,100.) The parts to be treated are placed loosely in boxes made of special high-nickel steel, which are in turn heated in electric furnaces to a temperature of 500 deg. C. After removal from the boxes the parts are ready for immediate use, no quenching being necessary.

Parts so treated will scratch glass with the greatest ease, and no file or tool will make the slightest impression upon them. A further advantage is that the hardness is retained up to a temperature of 500 deg. C., which is considerably above requirements for any parts usually subjected to mechanical wear. The finished hardened surface has the usual frictional properties of other classes of steel, so that no difficulty is experienced in the matter of lubrication where necessary.

Another important point in this system of hardening is that owing to the low temperature necessary for the treatment no distortion occurs as is common in case-hardening and similar methods, and the parts treated are absolutely free from deformation. Further, small parts of intricate design are treated with the same ease. The process is applied to parts in their finished machined condition; the only correction necessary when machining is to allow for the thickness of the deposit on the parts so treated, which may be taken as approximately 0.001 inch.

The numerous small parts in the industry which give so much trouble to maintain in good condition at the present time offer a considerable scope for this new process, such as the wearing surfaces of automatic packing machines, small shafts, gears, tappets, gudgeon pins, cams, rollers, spindles, clutches, Fuller Kinyon pump parts, sewing machines, etc.

The Cement Industry in Great Britain.

At the annual general meeting of the Associated Portland Cement Manufacturers, Ltd., held in March, Mr. P. Malcolm Stewart, chairman, gave a valuable review of the cement industry and of general industrial problems.

Referring to the trading position in 1928, he said they had at the outset to face a lower but not unsatisfactory average selling price than that they had enjoyed the previous year. Unfortunately the level of prices was not long maintained. The further co-operation advocated in his speech last year was not forthcoming for some time, and they had to face a period of intense competition which continued until the end of October and had left its trail of low-priced contracts to be completed. If co-operation were to be established, opportunities for friendly discussion must be facilitated. These were forthcoming. Ultimately, with the creation of a better understanding all round, wiser counsels prevailed and competitive manufacturers resolved to join the Cement Makers' Federation, the doors of which had always been kept open. Thus was the industry enabled to a considerable extent to stabilize selling prices. There was never any foundation for the statements appearing in the Press that their Companies had entered into agreements or made territorial arrangements. Further, it should not be assumed that on the cessation of price cutting such as was experienced the situation could immediately revert to the *status quo ante bellum*. No effort would be spared on the part of the Associated Companies to further the cause of co-operation, to the service of which he had devoted himself during the past 20 years, first as chairman of the Inland Cement Makers' Alliance and since as chairman of the Cement Makers' Federation. It was mainly due to the beneficent influence of the Federation that the industry had been able to pull through the difficult post-war period with a reasonable degree of prosperity.

After describing the reorganisation and modernisation of the works of the Associated Companies, he said that policy of co-ordination and increased efficiency could be rightly described as rationalization applied as far as was practicable in respect of a group of works representing a large proportion of an industry. The Associated Companies were operating no fewer than 20 rotary kiln works spread over the United Kingdom. Briefly stated, they had closed their smaller and less efficient units and increased the production at works equipped with the best economic advantages, thereby decreasing manufacturing costs. Further, they had reduced selling prices and increased the tonnage sold. At the same time, they had maintained the wages paid to employees; these to-day were well over 100 per cent. higher than paid pre-war, and were, in addition, earned in shorter hours. Complete rationalization was only accomplished in Germany after some of their industries had found themselves post-war in an even more disastrous position than that which had beset our basic industries, which had had in recent years to face the ordeal of such bad economic conditions.

However, increased efficiency and the adoption of improved methods of organization still left them faced with the problem of meeting successfully the competition of countries which, aided by favourable exchanges and sheltered behind their tariff walls, maintained high home prices. These prices, immune from attack, were in part used to subsidize their exports. It must be borne in mind that these advantages were not due to greater efficiency, superior technical knowledge, or even the endowment of better natural facilities. They were due to State support without State interference and to exceptional post-war conditions and to lower rates of wages. Those were the conditions with which they had at times to cope, and they were such as the lowest costs of production could not overcome. The carrying on of industry was no longer so simple as in the days gone by when they were the pioneers in railway and steamship construction and the commercial development of coal, and he might add of the manufacture of Portland cement, when in many directions they led the world. Policies then current under such different economic conditions certainly needed reconsideration to-day and might need revision. They might become as obsolete as machinery and call equally for scrapping. Surely a solution of those problems was of such pressing necessity, particularly with unemployment rife, that instead of each

party feeling it to be its bounden duty to prove that the remedy advocated by the other was impracticable, all parties in the State should unite and, with the help of the best brains, formulate a national industrial policy directed to the welfare of industry as a whole.

Year after year went by and they got little nearer to a solution of such problems, problems which were not of less importance than some of those which were successfully dealt with by the co-operation of all parties during the war. The modern trend was for each industry to consolidate and thereby benefit all concerned, but the day would come when it would be recognised that this, of itself, was insufficient and that sectional industrial co-operation was only a stepping-stone to a wider co-operation which would co-ordinate conflicting interests with regard to these major problems. Meanwhile let them above all strive for the attainment of such a degree of accord between trade union leaders and industrialists that they would jointly hammer out a solution. Any agreed policy so sponsored would receive the support of the majority, who were waiting for a decisive lead and would command the respect of politicians.

They were credited with being a practical nation, yet they had spent since 1921 over £300,000,000 in unemployment pay, not merely unremuneratively, but, owing to their failure to create constructive work with this expenditure, they had destroyed the aptitude for work and the *moral* of some of their best workers. However great the post-war difficulties and inevitable a transition period of comparative chaos, it was impossible to look back with pride on the record of the past decade in these matters. They had failed to effect much-needed economies and had lavishly expended national resources without obtaining any adequate return for the common welfare of the citizens of the State.

Whatever help or hindrance might come from legislation, there was room for something to be done by voluntary effort through the influencing of public opinion. The growing tendency to buy British or Empire goods was encouraging. The influence of "Buy British" propaganda was stirring the conscience of the buyer with sufficient imagination to visualize the dark picture of unemployment. If that propaganda was adequately supported it would create a habit which would enhance prosperity and help to fill the gap while they were searching for a policy.

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